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Small-Scale Mining in Africa: Its Problems and Future Prospects

SECOND REGIONAL CONFERENCE ON THE DEVELOPMENT AND UTILIZATION OF MINERAL RESOURCES IN AFRICA

SMALL SCALE MINING IN AFRICA
ITS PROBLEMS AND FUTURE PROSPECTS

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SMALL-SCALE MINING IN AFRICA: ITS PROBLEMS AND FUTURE PROSPECTS

Introduction

1. Nowadays small mines occupy a very important position in the national economy of most developing countries. The history of mining until the turn of this century has been essentially of small-scale operations using very crude methods, often hazardous to health and safety but nevertheless providing the necessary raw material basis for basic industries. However the turn of the century has seen a marked growth or large mining operations utilizing economies of scale.

2. In the past three decades or so development theories have emphasized the need for rapid industrialization, backed by the belief that benefits from large operations would trickle down throughout a national economy. Accordingly technical assistance programmes focused on the need for large scale operation which still dominates the scene.

3. However, in recent years, this approach has come under increased criticism in the developing countries as it was found out that little benefit was derived by the majority of people in society. The emphasis is therefore on a basic-needs approach to raising the quality of life and increased focus on the growth of self-reliant economy on rural development and utilization of appropriate technology.

4. In the field of mineral resource development there has been a shift of interest to small-scale operations. The United Nations undertook a major survey of small mining in developing countries (1972) which was followed by an international conference on the future of small-scale mining (Mexico, 1978). Even in industrialized countries where mining is the major industry there have been serious calls for re-emergence of the small mining enterprise.

5. The definition of a small-scale mine varies from country to country and is based principally on different factors such as number of people employed, size of concession, size of reserves, productive capacity, productivity, gross annual income, degree of capitalization, continuity of operations, etc.

6. However even these measurements have no uniform nature, what would be considered a large mine based on any of the above measurements in one country might well be considered a small one in another. Moreover different considerations must be given to different mineral commodities, such as high bulk low value minerals e.g. limestone as compared to low bulk-high value minerals e.g. gold, precious stones. The 1972 United Nations study adopted a definition that a small mine is one with an annual production of not more than 50,000 metric tons of unprocessed material, regardless of the mineral being considered. However during several other workshops and symposia on small-scale mines which followed, no such consensual definition became apparent. A recent study on distribution strategies for small coal mines in the United States had established a small coal mine as one producing 100,000 tons per year or less and a small coal producing company having an annual output of 200,000 tons or less. On the otherhand in China where 43.7 per cent

of the nation a coal production comes from small mines. The scale of small coal mine is quite varied. Some of the small coal mines have a production capacity of more than 30,000 tone per year.

7. Another major feature of most small-scale operation to quote the United Nations study (1972) is the involvment of "Artisanal mining" i.e. the direct involvement of human energy which can in some countries even exceed a production on a national scale of modern mechanical operations.

8. Major mineral groupings which are specially amenable to small scale are pegmatite minerals (e.g. rare earths, lithunium, mica, tin, tungsten), precious metals and industrial minerals.

9. Apart from these, small-scale mining requires easy accessibility, e.g. surface or near-surface mining.

10. Small-scale mining generally requires very low technology, e.g. as in precious metals specially if it is of placer deposit it does not need sophisticated technology to recover the precious metal be it gold or diamond for that matter.

11. Small-scale mining is also characterized on the organisational side, say by one person or family, by various forms of leasing or tributing where a miner shares the production with the owner, by joint ventures of all sorts and co-operative as well as wage labour.

II. Advantages and Disadvantages of Small Scale Mining Operations

12. The advantages of small-scale mining specially to developing countries can be reviewed as follows:

(a) They are labour intensive employing large number of workers in rural areas especially where placer deposits are involved e.g. 97 per cent of all operating mines in India are classed as small scale and employ nearly 50 per cent of the total mining workforce. There are about 13,000 tributors engaged in small tin/tungsten operation in Rwanda against 8,500 in mechanised mines, about 40,000 people are involved in small mines in Bolivia, 15 to 20 thousand in Central Africa in diamond digging, 15,000 in Venezuela (Meyer 1980) also in alluvial gold diggings in the former Kilo-Moto gold concession in Upper Zaire Province;

(b) One particular advantage in such mining is that it can be pursued on a seasonal basis;

(c) Small operations often lead to the discovery of large deposits. It is worth noting here that in the 50s in Canada small mining enterprises accounted for 62 per cent of all economic finds with expenditure of less than 30 per cent of total funds spent on exploration;

(d) Small-scale operations can also form the basis for local processing and manufacturing industries, either on small scale or as feeders to large centralized plants, e.g. diamond cutting, clays for bricks, silica sand for glass, gypsum for cement, etc;

(e) Small-scale mining are useful as substitutes for imports of mineral commodities and foreign exchange can also be earned through exportation of essential commodities;

(f) Small-scale deposits can generally be developed in relatively short time as compared to larger deposits and their operation also can be halted faster allowing quicker responses to changes in market conditions;

(g) Avoids some of the problems associated with large-scale mining such as financing, in dealing with transnationals, infrastructure (large sized) technology and expertise;

(h) A successful small-scale operation can be a good demonstration to skeptical policy makers; and

(i) Self-reliance and on-the-job training in mineral resources management.

13. Small scale mining has got its own disadvantages which can be reviewed as follows:

(a) Vicious exploitation of labour in terms of wages, working conditions, total disregard for health and safety;

(b) Can be wasteful, miners in many cases tend to mine only high value ores leaving behind low-value ores - known as high grading. Quite often the result of high garding is to lower the average grade of the entire deposit sometimes to the point where no known or anticipated mining methods can work it profitably;

(c) The problem of controlling and regulating small mines is immense as in precious metals, illicit operations are wide spread, smuggling is common and lawlessness prevails: These adversely affect revenues to governments; and

(d) Problems of financing.

III. Small-scale mining Activities in the Region

14. Traditional construction materials such as sand, gravel, clay and stone are produced in several African countries. However the production of other minerals, be it ferrous or non-ferrous, is limited to very few African countries.

15. The mode of production of many of the mineral commodities involves 'artisanal mining' utilizing primitive tools and the entire operation sometimes is handled by a person or a group and very rarely by co-operatives.

16. In most cases no statistics or very scanty and scarce information is available regarding such activities in virtually every country of the continent making it difficult to give precise information of such activities and scale of production.

17. At times the statistical information available could be either misleading as it does not represent the actual picture or sometimes out of date.

18. In this chapter an attempt has been made to describe small-scale mining activities in several African countries and production figures wherever it has been possible to give such figures.

19. It is therefore in no way exhaustive, as documents available to date regarding small-scale mining activities in the region are very scanty and without the necessary details.

Botswana

20. Gold and silver have been mined from time to time. Two mines in the south-eastern part of the country have been producing a few thousand tons of manganese ore. Talc is being produced in annual quantities ranging from 50 to 700 tons.

Burkina Faso

21. The Poura gold mine with an estimated reserve of 22 tones of gold contained in 1.5 million tonnes of ore which is scheduled to open in mid-1984 is the country's only active new mine project. Production is planned at 2,500 Kg/year.

22. Other minerals produced on small scale are phosphate currently producing some 3,000 tones/year and marble with production of 60,000m^3.

23. There are plans for large-scale manganese mining project at Tambao which production could be of the order of 650,000 tonnes/year but has not been implemented pending the extension of the Abidjan-Niger railway some 350 Km north-east of its current terminal at Ouagadougou, to the mine site.

24. A new metallogenic province has been identified in Burkina Faso in the course of a UNDP survey from 1974 to 1988 covering a 38,000 Km^2 area west of the capital. Several promising occurrences of gold nickel-cobalt, sulphides, copper and tungsten have been outlined some of which might be developed in small- to medium- size mines in the future. In addition the major discovery during this investigation was the Perkoa lead-zinc mineralization extending over a strike length of 500 m and intersected at depth by boreholes down to 300 meters.

Burundi

25. Alluvial and primary cassiterite and to be produced until 1978 largely by artisanal mining. Gold is produced in a few hundred ounces quantity from a small mine and bastnaesite from a small underground operation where operation was stopped in 1979.

26. In addition peat as domestic fuel, has been exploited at the rate of 10 to 15 thounsand tonnes annually over the last 5 years with small means involving essentially manual labour.

Cameroon

27. Small quantities of gold (1,000 troy ounces a year) are mined from alluvial deposits in the Beteau - Oya region. Around 10 to 15 tonnes of tin per year have been produced over the last 6 years from pegmatites by hand labour from the Mayo-Darle area.

Central African Republic

28. The Central African Republic is an important producer of diamonds and the largest portion of the annual output generates from the efforts of individual placer miners.

Chad

29. Apart from a small quantity of building materials such as granite, gravel and rhyolite and ilmenite the only other mineral produced is natron, an impure mixture of sodium carbonate and sodium chloride on the north-east shore of lake Chad by artisanal mining on a seasonal basis.

Congo

30. Some unrecorded production of clay and construction material is carried out on a small scale. Copper, lead and zinc are produced in small quantities from the M'Passa Mine in Niari valley while artisanal mineral recover minor quantity of alluvial gold with pans and small sluices. A little less than 50 tonnes per year of tin was produced until 1968 primarily from two lode deposits.

Egypt

31. There is a reasonable amount of small scale mining activity in Egypt. Manganese ore is being mined at the rate of 4,000 tonnes for local consumption. Kaolinitic clays are being produced at annual rate of 60,000 tons from the Kalabsh deposit in Nubia district since 1967. Talc is mined at an annual output of 5,000 tonnes from the south-eastern desert. Bentonite is quarried north of Fayum to produce 5,000 tonnes annually for local consumption. Gypsum for the cement as well as for agricultural use in quarried from deposits west of Alexandria. Diatomite, feldspar, fluorspar, asbestos, vermiculite, barite and magnesite are mined for local uses, in small amounts from several sites in the Eastern Desert.

Ethiopia

32. Gold and platinum are being produced on a small scale from the Adola goldfields and Yubdo respectively. Apart from gold and platinum there is no other metallic production. Other mineral production included, building stone (1,967,500 m^3), Pumice (30,000 m^3), Kaoline (74 tonnes), gypsum (4,200 tonnes not including raw material for cement industry), marble (56,000 m^3), diatomite (330 tonnes) all from small-scale operations.

Gabon

33. No quantitative data are available concerning the production of construction and industrial minerals. Small scale mining had been largely confined to placer mining of alluvial diamonds and alluvial and eluvial gold. There is no recent data available as to whether diamonds and gold are being mined. Uranium is also mined from three deposits. Uranium production so far stands at about 1,000 tonnes per year of concentrate.

Ghana

34. Small-scale mining appears to be confined solely to diamond mining both legal and illicit. No figures are available on production from diamond diggers, however the contribution from legal diggers is estimated to be about one per cent.

35. Though all Ghanian gold comes from large underground mines, at the present stage there is one mine, the Ashanti Gold fields mine, with a production ranging upto 7,500 Kg in 1982 year whereas the Tarkwa, Prestea and Kononga underground mines together with the Dunkwa dredging operations produced together 2,200 Kg of gold.

36. Bauxite production for fiscal year 1983 was about 70,000 tonnes.

Guinea

37. Virtually no information is available concerning small-scale mining activities in Guinea. There are small scale private diamond diggers perhaps producing about 6,000 carats.

Ivory Coast

38. In earlier years there was considerable small-scale and artisanal mining of diamond accounting for upto 35 per cent of total production. However this practice was stopped by the government in favour of large mechanized mining as it was very wasteful.

39. Recent exploration activities have revealed deposits of gold vein and alluvial type in the South-East of country close to the Ghana border which could be suitable for small-scale mining.

40. In addition the Itg deposit under investigation for more than 20 years could lead to a small operation (open cast and underground) with reserves of the order of 18 tonnes of gold.

Kenya

41. Kenya provides a good example of the significant economic contribution that can be provided by small-scale mining. Except for the production of limestone for cement, virtually all other mineral products are essentially from small-scale mining. Production figures for the year 1983 stand as follows:

Soda	-	193,690 tonnes
Fluorspar.....	-	60,464 "
Limestone products	-	52,031 "
Diatomite	-	1,735 "
Kaolin	-	1,150 "
Gypsum	-	2,000 "
Wollastonite	-	900 "
Barytes	-	2,000 "
Verniculite	-	1,600
Semi precious stones	-	150 Kg (Amethyst, Aquamarine Garnet, Ruby. Sapphire, Tourmaline)

42. In addition a number of small mining ventures are under consideration. A project to produce talc for the paper industry from a talc deposit has commenced.

43. The Ol Doinyo Ng'iro deposit located north of Nabyuki is under investigation as a source of graphite. Evaluation of the ore body is completed and preliminary testing for flowsheet design is underway.. Recovery of gold from old dumps with cyanide leaching and carbon-in-pulp technology are also at the planning stage. The production of lead from galena concentrates from vitigeni near Mombasa was commenced. Upto 1,000 tonnes/month of galena concentrate will be consumed in the future to meet local demands.

Liberia

44. The contribution of small-scale mining to the Liberian mining sector is insignificant.

45. There is some gold and diamond production going on, on a small scale. Current gold production in the country is estimated to be running at about 40-45 Kg/month. It is difficult to estimate diamond production because of the level of smuggling.

Madagascar

46. Madagascar has a variety of semi-precious stones, some of which are unique to the island.

47. Many varieties of quartz occur in the island and include amethyst, citrine, rose quartz, smokey quartz, piezo-electric quartz and quartz for the smelting industry. Production of quartz for the smelting industry amounted to 232 tonnes (1978), piezo-electric to 74 tonnes (1978) and rose quartz to 64 tonnes (1978).

Malawi

48. Has small-scale production of lime, gemstone, alluvial gold and other industrial minerals. Local sales of lime were about 2,500 tonnes in 1983.

Mali

49. Mali is renowned for its gold potential since ancient times and has extensive alluvial, eluvial diggings worked since times immemorial in the Faleme valley and tributaries along the Senegal border over an area of 200 Km^2 where several thousands of diggers produced around 500 Kg of gold in 1982. Productions as high as 1 to 2,000 Kg per annum are recorded in the same area over the last 20 years.

50. Recent research work by the BRGM in association with the geological survey of Mali has identified a primary deposit at Loulou in the same area were grades of 15 gr/tonne are encountered during investigation comprising diamond drilling, shaft sinking and mine development.

51. In addition Mali is developing the Kalana underground mine with the technical assistance of the USSR. Production at a rate of 400/Kg/year raising to 1,800 kg should have started some years back but was deferred on account of technical problems.

52. Mali is also emerging as a pioneer in the production of low-cost fertilizers in the Tilemsi Valley where 26 million tonnes of medium grade (28 per cent P_2O_5) phosphate have been identified. Production was at 10,000 tonnes in 1982 but is targeted for 30,000 tonnes for local consumption after fine grinding and compounding with some imported acidulated phosphate.

53. Other mineral exports, measurable in kilogrammes include silicified wood, moss agate, amazonite, labradorite, cordierite, garnet, rhodonite and mineral specimen.

54. Apart from semi-precious gems, Madagascar produces graphite - 13,548 tonnes (1983 fig), chromite - 42,920 tonnes (1983) and mica (phlogopite) - 1,096 tonnes (1983).

Mauritania

55. Apart from iron ore being mined at a large scale, there are no significant medium- small scale mining operation in the country producing up to 23,000 tonnes of copper in 1973. However after operating from 1970 to 1975 the mine was closed due to processing problems in 1978. Reactivations plans are under consideration and would also imply the secondary recovery of some 10 to 12 tonnes of gold in

the old tailings. The only other mining activity on small scale has been the extraction of gypsum for export producing about 14,000 tonnes/year. Production was halted in 1981 but is scheduled to resume by the end of 1984 with sharply increased output.

Morocco

56. Morocco apart from being one of the leading producers of phosphate rock has several small- to medium-scale mining activities. They include oil, iron ore, manganese, zinc, cobalt, copper, barytes, pyrrhotite, fluorite and antimony. Production figures for 1981 are as follows:

Oil	-	17,523 tonnes
Iron ore	-	49,900 "
Manganese (chemical grade)	-	168,400 "
Zinc concentrate	-	14,670 "
Copper concentrate	-	23,300
Cobalt concentrate	-	6,265 "
Barytes	-	463,860
Pyrrhotite	-	76,225 "
Fluorite	-	66,700 "
Antimony	-	1,020 "
Tungsten concentrate	-	3,020 "
Mica	-	1,805

Mozambique

57. With the exception of coal, the mining industry can be categorized as small scale. The tin and columbo tantalite bearing pegmatite deposits of the Zambezie and Mozambique districts are very attractive for small-scale mining. Minerals being produced at small scale are columbo-tantalite, bauxite, asbestos, mica, copper, gold, phosphates, monazite and a variety of semi-precious stones. However production statistics are not available except for beryl, crystals (2,000 Kg) and garnets (12,000 Kg) in 1982.

Niger

58. Uranium which is produced from three different localities on a large scale accounts for a third of government's revenue and about three-quarters of the country's export revenue.

59. Apart from uranium (molybdenum is also produced as a by-product_ and coal whose production has reached the level of 150,000 tonnes in 1983, there is small-scale production of cassiterite, salt and phosphates. Annual production which was sustained at the level of 140 tonnes/year of 70 per cent until 1974 declined to 47 tonnes/year in 1982 and rose to 70 tonnes in 1983. A small phosphate deposit is being exploited at the rate of 5,000 tonnes/year and is being utilized to produce low-cost finely ground phosphate rock for direct utilization as a soil nutrient.

Nigeria

60. Nigeria, one of the major oil producers in the world, still largely depends on this commodity. However conscious efforts are being made to diversity.

61. On the small scale scene Nigeria produces coal, tin and columbite. Cassiterite production for 1983 was 1,739 tonnes of which over 70 per cent was produced by Amalgamated Tin Mines of Nigeria Ltd., the rest being produced by the other five major mining companies. The production of columbite stood at 93 tonnes for 1983. During the same year some 53,000 tonnes of coal was produced from three different mines.

Rwanda

62. The mining industry in Rwanda, which is virtually of small scale, ranks second in importance after coffee in the country's economy, and exports in 1983 provided about 15 per cent of foreign exchange earnings. The minerals being produced are tin, tungsten, columbo-tantalite, beryl, wolframite and small quantity of gold.

63. Production of tin and tungsten ores is derived from industrial mining (open pits and underground) contributing 40 per cent of the annual output whereas that of the tributors is equivalent to 60 per cent of the mining sector's overall production.

64. In 1983 Rwanda produced 1,520 tonnes of cassiterite, 429 tonnes of tungsten ore, 32 tonnes of beryllium, 50 tonnes of niobo-tantalite and about 21 Kg of gold.

65. The Mining sector operates also a tin smelter which has a capacity of 4,000 tonnes of tin per annum and was commissioned in 1982.

66. Rwanda ranks fourteenth in terms of world tin production and the industry employs a workforce of about 20,000 (13,000 indirectly).

67. In the fuel sector, Rwanda has considerable peat reserves estimated at 2 millions m^3 and is in the process of experimental development of these resources for domestic consumption.

Senegambia

68. Apart from the production of phosphate on a medium to large scales, the only small-scale mining which is planned for 1984 is the production of gold from the Sabodala deposit, in south-western Senegal. Planned production is 300 Kg/year, starting from the end of 1984 for a three-year period after which production will be raised to 800 Kg/year for a period of 14 years.

Sierra Leone

69. Small-scale mining in Sierra Leone is limited to licensed alluvial diamond mining by individuals and groups.

70. Under the alluvial diamond scheme specified areas are set aside for licensed digging by individuals or small local firms.

71. There are some sophisticated and capital intensive small-scale alluvial diamond mining employing machinery like airlift dredge.

72. The licensed miners and small firms have consistently accounted for a large proportion of the annual diamond output as compared with the large-scale operation by the National Diamond Mining Company.

73. Production of diamond for 1983 was about 369,000 carats of which 121,000 or about 35 per cent came from the operations of the national company.

74. Gold is also produced on small scale by individual diggers. However there is no statistics available regarding production.

75. The Marampa Iron Ore Mining Company Ltd., commissioned in December 1982, produced about 356,000 tons of iron ore in 1983 while the rest of mining by dredge resumed in 1979 and produced 47,000 tonnes in 1982.

Sudan

76. Sudan's limited mineral production comes from small-scale mining operations.

77. Chromite, Sudan's principal mineral product is being mined at the Ingessana Hills area. Production of chrome ore for 1983 was some 19,000 tonnes. About 13,000 tonnes of gypsum was produced in 1983 and some 25 Kg of gold from tailings at the Gabeit mine. Full production from the Gabeit mine tailings using cyanide leaching is expected to reach some 200 Kg/year. Meanwhile systematic exploration by diamond drilling took place in the same area in 1983/84 and has outlined considerable reserves of medium to high grade, likely to lead to the establishment of a medium size mine.

78. Some 30 to 500 Kg of alluvial gold are also produced annually in the Kapoeta district of Southern Sudan in 5,000 Km^2 area, 350 Km east of Juba, by hundreds of small diggers. Most of the production is marketed outside the country.

79. Exploration for oil, specially by Chevron, has yielded modest results. The 20,000 barrels potential daily production announced by the company in September 1981 can be considered a small-scale operation.

Swaziland

80. Iron ore production (large-scale operation) ceased in 1979. The major mining products are chrysolite, asbestos and coal and a variety of industrial minerals mined in small quantities.

81. Asbestos exports accounted for 5 per cent of the country's foreign exchange earnings. Production for 1983 was about 30,000 tonnes of asbestos fibre. In terms of mine capacity, which is 2,000 tonnes/day, asbestos mining can be considered as large scale, whereas actual asbestos fibre production stands at 30,000 tones.

82. The only existing colliery at Mkapa produced about 100,000 tonnes of coal in 1983.

83. No statistics is available regarding production of industrial minerals. The mining sector contributes about 3 per cent of the total GDP.

Tunisia

84. Tunisia, apart from being the fifth largest phosphate rock producer at 5.2 million tonnes in 1983, has significant small- to medium-scale mining activity.

85. Mineral produced on small scale are lead, zinc, fluorspar, aluminium fluoride, barytes, etc.

86. Mine output of zinc as reported by the World Bureau of Metal statistics was 8,000 tonnes in 1983 while production of lead stood at 4,600 tonnes for the same year and output from the Mergine Leas Smelter 12,200 tonnes. The production of aluminium fluoride was 20,139 tonnes in 1983. Production figures for 1981 stood as follows:

Lead concentrates	-	9,973	tonnes
Zinc concentrates	-	14,831	"
Lead metal	-	17,821	"
Fluorspar	-	35,055	"
Aluminium fluoride	-	20,308	"
Barytes	-	24,945	"

United Republic of Tanzania

87. The mining industry in Tanzania between 1920's and late 60's was a flourishing enterprise when varied development and exploitation of minerals on small scale took place. During this period there was significant exploration and a number of small- to medium-sized gold tin and base metals and diamond mines were brought into production.

88. However starting early in 1970s production decreased considerably following the closure of several base metal and gold mines.

89. Apart from the several freelance miners producing gold and in small quantity tin in Mpanda, Lupa, Ceita and Kyerwa, there are presently six mine developments at various stages.

90. The Buck Reef Gold Mine started production in October 1982 and at full capacity is expected to produce some 400 Kg of gold per year.

91. The Minjingu Phosphate had also come into production by the end of 1982 and at full capacity is expected to produce some 400 Kg of gold per year.

92. The Minjingu Phosphate had also come into production by the end of 1982 targeted to produce 100,000 tonnes/year of concentrates to feed the Tanga fertilizer factory.

93. Pugu Kaoline in Dar es Salaam is at present producing about 400 tonnes/year for local consumption and there is plan to expand the mine in order to enable it to export the good quality and earn foreign exchange.

94. There is plan also to increase salt production to cover a 100,000 tonnes/year from the present installed capacity of 32,000 tonnes/year.

95. Plans are also under way to develop a coal mine at Songwe Kiwire- Mbeya Region with an annual production of 150,000 tonnes/year of coal. At present the Ilima Colliery is producing very small amount of coal for local consumption.

96. Apart from these mica and gemstones are produced in small quantities from Morogoro and other areas.

Uganda

97. Most of the mining activities in Uganda since the closure of the kilembe Copper Mine in 1977/78 is of a small-scale nature and concerns the production of tin, tungsten and columbo-tantalite, the latter two amounting to 25 tonnes each in 1982.

Zaire

98. Small-scale mining has little significance in Zaire by comparison to large-scale copper-cobalt operations in the Shaba province whereas the diamond mines are situated in Kasi province.

99. However small-scale operations dominated the scene in the Kivu, Manienia, North Shaba and Copper Zaire Province with respect to assiterite, columbo-tantalite and gold.

100. Gold is being produced by individuals and clandstine diggers numbering between 30 and 40 thousands in Upper Zaire province and (Kilo-Moto, Sominki and Gecamine) amounted to 1.5 tonnes.

101. The production of tin-in-concentrates stood at about 2,000 tonnes for 1983 and is derived from a considerable number of small operations in alluvial, eluvial and primary ore. In recent years a distinct switch from mechanical and semi-mechanical mining to artisanal activity is noted and is the result of uneconomic character of most of the deposits.

102. There is also quite a significant illicit production of diamonds by individual diggers (it is estimated as equivalent to official production).

103. Oil is being exploited from offshore deposits at the rate of 22,000 barrels/day.

Zambia

104. Zambia is expected to expand its small-scale mining sector which is essentially concerned with semi-precious stones, in particular, high-quality amethysts and emeralds estimated at $100 million in 1982 but subject to considerable illicit mining and smuggling.

105. In the field of fertilizers materials small size (400,000 tonnes reserves), low grade occurrences of apatite associated with intrusive limestones and carbonatites are known in the Eastern province and are under investigation for exploitation.

Zimbabwe

106. The Zimbabwean mining industry has long been the main backbone (together with agriculture) of the country's economy. Although Zimbabwe produces a wide variety of mineral commodities, six minerals account for more than 90 per cent of annual output value. These are gold, copper, nickel, chrome, asbestos and coal.

107. Gold has continued to be a major factor in the country's mineral sector. Much of the gold output comes from a large number of small mines' operations. However no production figure is available for these operations.

108. Production figures for 1983 from different mining companies are as follows:

109. (a) Coronation Syndicate, a Lonrho subsidiary produced 1,598 Kg from its three mines arcturus (541 Kg), Mazos (367 Kg) and Murial (640 Kg);

110. (b) MTD (Mangula) Ltd.; 281 Kg from Miriam Norah mines and 122 Kg by Merits Ltd.

111. (c) Rio Tinto Mining, Zimbabwe: 1,843 Kg from Renco gold mine, 507 Kg from Patchway/Brompton operation and 168 Kg from Camp dump retreatment operation.

The total production of gold for 1983 was 14,560 Kg.

112. The small-scale mining sector, apart from gold, has a significant importance in chromite production (450,000 tonnes) and to a lesser degree in that of tin. Tin production for 1983 was 1,235 tonnes of metal. However the bigger proportion of production comes from a few large mines.

113. Other minerals known to be produced in the country on small scale are corrundum (estimated output about 5,000 tonnes/year), magnesite, phosphate, tungsten, antimony, and several others. With regard to refractory minerals Zimbabwe comes second after South Africa and produced the following range of these minerals in 1982:

(a) corundum : 8,714 tonnes

(b) graphite : 8,225 tonnes

(c) Fire clay : 11,746 tonnes

(d) Magnesite : 60,660 tonnes all of which are produced in small size operations.

IV. Problems Related to Small-Scale Mines Development

114. There are numerous problems related to small-scale mines development starting from the exploration stage upto the development.

(a) Successful mineral development depends on the exploration work conducted on a mineral deposit using the different sophisiticated tools of exploration such as geochemistry, geophysics, drilling, etc.

The exploration phase of small-scale mining, which definitely follows the pattern of any exploration programme, is generally the domain of the individual miner or co-operative. The cost of conventional exploration for minerals is so big it would be beyond the means of the individual miner or small-scale entrepreneur to support it.

The tendency of the individual miner or prospector has been to concentrate his efforts on such minerals which are amenable to traditional methods of exploration - minerals such as gold, platinum, diamond and gemstones which are easily identifiable without involving sophisticated exploration methods.

(b) For the individual small-scale miner, exploration ends with the discovery of the mineral. For the kind of mineral deposit commonly sought by individual miners, evaluation and exploitation are virtually the same. In the case of alluvial deposits, either it provides an adequate return of valuable mineral per unit of time or if it does not it is abandoned. in the case of hard rock, either the miner finds an outcrop or follows strong surface indications by shallow edit or shaft.

(c) Development

The first step in the exploitation of an ore deposit is development - the process of opening up the deposit for mining.

For the individual miner who makes a discovery of relatively high-grade ore, mining or development starts in a fashion as to produce income from the ore as quickly as possible and development work is virtually absent.

On the other hand small-scale mining of base, ferrous and non-ferrous minerals even to a small scale requires exploration work involving a substantial sum. This is usually undertaken by the individual entrepreneur or a group or in some cases by individual organizations specializing in such activities on a contractual basis.

But this is not the case in most African countries and exploration, evaluation and development of small mineral deposits requiring integrated approach unless assisted by specialized government agencies, cannot be undertaken by the small-scale miner as he doesnot have the means or the technical know-how.

Until such time, that the small-scale mining sector in the individual countries are fully developed, its activity will remain limited to the production of precious minerals and stones, quarry products, salt, sand clay and some industrial minerals. However cassiterite, tungsten and columbo-tantalite mining might be an exception to this rule since some 90 per cent of Africa's production of those commodities amounting to 8,000 tonnes is produced in small-size operations and there is furthermore a new trend which indicates that this activity is gradually overtaken by artisanal miners and tributors who are already contributing to more than 50 per cent of the total annual production in the countries concerned.

115. It is therefore important, and discussed in the next chapter, for governments to create incentives to promote small-scale mining activities in the region.

V. Prospects for Future Development

116. The contribution of the mineral sector in general to the overall economy of many countries in Africa is relatively small. Even in the exceptional cases, where minerals are significant contributors to the GNP of a country it is essentially derived from large-scale mining operations. On the other hand the direct contributions of small-scale mining to the economy is not quite significant.

117. However, small-scale mining can have significant long-term impact in the economy of a country as it could serve as import substitute. This is specially important when it comes to industrial mineral products, construction and chemical minerals. Cement, aggregates, ceramics, fillers, fertilizers, glass and glasswares, etc. are among the imports which consume foreign exchange which is in short supply in many countries in the region.

118. Small-scale mining to a degree can also serve as foreign exchange earner from direct exports. This is especially true when we take into consideration mining products such as diamonds, gemstones, gold, tin, etc.

119. Jobs, incomes, taxes, etc. which can be generated through the development of small-scale mining can be quite significant to developing countries.

120. Small-scale mining has got its own negative features which are measured in terms of primitive technology, high grading of a deposit by the small-scale miner, lack of social benefits and legal protection, safety hazards, etc.

121. However, small-scale mining if allowed to flourish, can make a significant contribution to a nation's economy and mineral reserves in terms of new discoveries. In many developed countries a large number of deposits discovered and brought into production owe their discovery to the small miner.

122. Small-scale mining, as practised in many countries in Africa is essentially "artisanal mining". The basic concept of artisanal mining is the direct application of human energy on a one-to-one ratio to the physical production without a multiplying factor by mechanical means. This is especially true to the practice of one man panning for gold or diamond or chopping coal with a pick or each member in an organized group is assigned a job such as digging, sorting or transporting ore. Few improvements in techniques appear to have evolved over the centuries in areas where artisanal mining is prevalent. However the artisanal miner when faced with complex technical problems has demonstrated skill in devising methods and equipment to overcome the problem.

123. The second component of small-scale mining is the application of modern techniques and technology to the production of minerals on a limited scale in order to reduce losses in the recovery which is a serious matter of concern since they account for some commodities to as much as 50 per cent of the total mineral content of the material processed.

124. The practice of small-scale mining using modern technology is limited to very few countries in the region.

125. It would be therefore essential that the vast artisanal mining practice prevailing now in several countries in Africa should through the introduction of modern techniques and technology be made more productive and raise its contribution to the economic development.

126. From the foregoing it can be concluded that the development of the mineral sector in general and that of small-scale mining in particular is of significant importance in the region.

127. There are relatively very few countries in Africa where small-scale mining is successfully and efficiently practised. Examples are Zimbabwe where a significant amount of the country's gold output is contributed by the small-scale mining sector; Sierra Leone, where under the Alluvial Diamond Mining Scheme licensed miners have accounted for a larger proportion of the annual diamond output.

128. These relatively small successess were brought about by favourable government policies in terms of tax incentives, funding through loans for purchase of mining equipment, technical assistance, government subsidies, etc.

129. It is therefore pertinent that other African countries learn from the successes of countries like Zimbabwe for the future development of small-scale mining in their respective countries. There is also need to create specific institutions attached to mineral resources development organizations which will be entrusted with the task of promoting the small-scale mining sector. The institutions thus entrusted with this task should ensure that:

(a) all data regarding mineral occurrences and other infrastructural necessities are available;

(b) educational facilities are fostered in order to educate the mass in all disciplines required to successfully carry out all the facets of the mineral industry;

(c) there is readily available market for the mineral products;

(d) equipment and all essential consumable supplies are established at convenient location and essential services such as analytical facilities fostered;

(e) a favourable economic climate with reasonable tax based and a regulatory structure that protects the safety and health of the miner be established.

130. If the above points are realized, the small-scale mining sector will have the needed incentive to begin successful operation and the prospects of the future development of the sector ensured.

VI. Training with Reference to the needs of Small Mines Operation

131. In the field of mining, unfortunately, there are to date very few national professionals in many countries of Africa and very little is being done to remedy the situation. It is therefore evident that in this field governments should seriously consider training programmes to provide personnel in the field of mineral resources development in general and for the small-scale mining sector in particular an industry which is in great need of skilled miners, experienced middle-level technicians and management personnel.

132. To this end it is required that first, practical training at various levels be conducted. Secondly, the establishment of training institutes designed to turn out technicians with sound practical knowledge should be established. Thirdly short ecurses and seminars aimed at installing sound planning and financial management concept should be organized for management-level personnel and small-scale mine owners.

133. In the developing world in general and the African region in particular where the small-scale mining sector is virtually undeveloped, it is needless to point out that those involved in this activity have very limited technical and financial know-how and managerial skills. It is therefore imperative that training should be focused on this area.

134. Generally, before launching any training scheme, sound analysis of manpower requirements at present and in future should be conducted. This is very vital in order to determine the level and volume of training required in the specific field.

(a) Practical training for miners

Practical or on-the-job training is very essential. Crafts such as driving heavy trucks, operating earth-moving equipment, drilling and blasting is an integral part of mine activity. Miners therefore should be trained to become qualified in operating mining equipment and machinery be it underground or on surface.

(b) Training of high-level technicians

The training of high-level technicians should be conducted in an institute designed to give more practical training in the several disciplines required in mining.

The training course should be designed to turn out mine surveyors, engineering and geological assistants, metal assayers and mill technicians or etc. The entrance requirements should not be less than secondary school leaving certificate and should offer a two-year course covering disciplines such as:

Mathematics (2 years), Physics (1 year), Chemistry and ore analysis (2 years) Fire assaying and Pyrometallurgy (1 year) Mineralogy - geology (2 years) Ore dressing and milling (2 years) Mining (2 years), Mine and plant environments (1 year), Surveying (2 years), Drafting (2 years) Industrial organizations (2 years) Statistics and strength of material (1 year) and Computer concepts (1 year).

The course however could be extended by another year in order to advance the technicians to supervisory positions.

(c) Short courses and seminars for management personnel

Personnel at management level should attend short courses and seminars coupled with visits to typical mines designed to improve management capability. Such training should concentrate on subjects like:

- Minimum standards in regard to health and safety;
- Dressing practices such as sizing, maintaining chemical balance and developing proper mix with reagents;
- Financial matters.

VII. Financing of small mining

135. In small-scale mining undertaking or any mining undertaking for that matter, financing is required starting from the initial exploration stage through development and construction and even future expansion stages.

136. Leaving aside the lone prospector, organized exploration even on a small scale is an expensive venture. An exploration programme involving geochemical, geophysical techniques, diamond drilling, assaying, etc. including logistical and other support requires a lot of money, whereby even a small mining company or a co-operative will have a major problem acquiring funds for an exploration programme.

137. Once a deposit has been found, a feasibility study must be undertaken in order to determine whether the deposit is economically viable for mining. The feasibility study involves such work as preliminary designs of the mining system, mine plant, infrastructure, etc. It estimates the capital and operating cost of production. A projected financial cash flow obtained from the evaluation and calculation of the relevant engineering estimates in the feasibility study will give good indication of the economic parameters of the venture and help to determine whether it is economically viable to bring the project into the next stage which is development.

138. Assuming that the feasibility study has indicated that the deposit is economically viable and can be brought into production, funds must be raised for engineering design: for the construction of the mine and ancillary facilities; for the purchase and installation of mine and milling plants. In a small-scale mining undertaking it is calculated that the plant normally costs four to five times the cost of the exploration programme and in specific cases where a complicated ore body is encountered the proportion can go even higher.

139. A mine development cycle normally involves reconnaissance survey and exploration using different techniques upto the drilling stage. This is followed by a pre-feasibility study involving further exploration by drilling to delineate the deposit and sinking of exploration shafts, adits, etc. (if it is underground) and final feasibility study. Then investment decision has to be made after which the mine or the deposit can be developed and brought into operation.

140. A mining venture, specially during the conceptual and exploration stage, is considered to be a very high risk venture. Even during the proving-up stage, i.e. upto the time its final feasibility study has been established, the risk is considered to be on the high side. During mine development the risk is limited and it becomes normal during the operation stage.

141. The source and method of financing a small-scale mining venture differs from stage to stage. During the exploration stage the source of financing entirely comes from initial investors, i.e. owners of a property or holders of either prospecting or exploration rights. During the development stage,

apart from the initial investors finance could be available from secondary investors in terms of equity participation and is even possible to secure long-term loans. During the operation phase, where the risk is considered normal, funds could be raised through short-term lending.

(a) Financing during the exploration stage

142. The exploration stage represents the highest risk in any mining undertaking. The small-scale operator has himself to raise the funds necessary for this stage. However in cases where exploration requires geochemical and geophysical techniques and drilling raising the cost of exploration to a proportion whereby either the operator or a company or a co-operative cannot manage by themselves, the necessary fund can be raised through joint venture with other companies or from well established mining companies.

143. While such kind of arrangement is possible in countries with a long background of mining history, however in most African countries such arrangement might be difficult. If we are to promote small-scale mining, it will be essential for governments through their geological or mine development organizations to assist individual miners or co-operatives by undertaking such exploration programmes for the benefit of the industry to flourish.

(b) Financing during development and plant construction

144. Assuming that a deposit has been found, explored and its feasibility study indicates that it could be brought into production, the operator/operators or the co-operative needs to secure funds for equipment, buildings and other ancillary facilities. As the amount involved is quite large, it is impossible to generate it internally. The funds required for this stage could be raised through borrowing from banks and other financial institutions in countries where such arrangement is possible.

145. It is true for this stage also that in many African countries such arrangements do not exist. Again, government assistance would be required which could be in terms of creating special institutions in the form of a mineral bank as a principal source of capital for the small-time operator and mining co-operatives or it could be an agency which will be entrusted in the direct development of small-scale mining and has got investment capability. Besides such a bank or agency could operate ore-purchasing depots; could sell ore concentrates domestically or abroad; could provide machinery and supplies on credit and could set up beneficiation plants in strategic areas for the benefit of the small operator.

146. Such an arrangement not only provides solution to the financial problem of small-scale mining activities but also to the marketing problem which is equally important.

VIII. Marketing of products

147. Among the numerous problems that a small mine faces, the greatest could be considered to be marketing. In fact finding a market for the mine product at an advantageous price is often a major obstacle to the viability of a small mine.

148. There are many factors affecting the marketability of a mine product, the major ones being proximity of a mine to a potential smelting plant, content of undesirable material in the product for the smelter, lack of production plans making it difficult for the miner to negotiate satisfactory long-term contracts, freight problems whereby the miner is forced to ship his product on a quarterly or half-yearly basis or even at times, once a year presenting financial problem to the miner, communication problem, etc.

149. A small mine rarely has the reserve to justify investment for processing facilities in order to upgrade the product. Therefore the small mines are forced to sale the raw products from the mines to processing firms. However, more than often what could be desirable material for one processing firm could be considered deleterious impurity for another. This often results in a processing (smelting) firm penalizing the miner for this undesirable impurity thus affecting the price the miner gets for his product.

150. Often such material considered to be undesirable for the smelting firm and for which the miner has been penalized could turn out to be useful as it could be recovered as a by-product. Though this should have been credited to the miner, but he gets penalized for it because of his ignorance.

151. In order to alleviate such problems on the part of the miner, there is a necessity for good, sophisticated technical and marketing information. It is also necessary, from the marketing aspect, to have a thorough production plan and a detailed understanding of the nature of the material to be produced. Impurities as well as payable metals from the product should be established in order to highlight at the earliest stage those elements which could inhibit the marketability of the product.

152. It is desirable to at least produce material concentrates, as during the concentration process some of the undesirable impurities from the mined ore could be discarded. This may present a difficulty for the small miner as he would not have the necessary fund to put up the required facilities for a concentrating plant. However in a mining district where there are several small mining activities of one or more associated minerals, this problem can be alleviated by jointly putting up a central plant or more depending on the volume of production.

153. As explained in the previous chapter, special government agencies should be created in order to give the necessary services by establishing ore- or concentrate-buying deposits. These agencies could act as intermediary between the miner and the smelter (or could operate their own

smelting plants) by purchasing ores and concentrates with prompt payment, blending and accumulating several productions and utilizing larger volume for economic freight. These agencies should also provide interim financing to the mines in order to enable them commence production with the knowledge that prompt payment will permit further development.

IX. Conclusion

154. Quite a substantial experience in small-scale mining has been recorded in the past. However, small mining firms, co-operatives and communities which once were flourishing are dwindling away. Naturally there is need for research and careful examination in order to identify the factors which contributed to the success or failure of small-scale mining activity which needs a careful survey on a nation-by-nation or commodity-by-commodity basis.

155. Realizing the need to promote the small-scale mining sector the United Nations organized a conference on small-scale mining of the world which was held in Mexico in November 1978 which attracted many experts from both the developing and the developed nations.

156. The Mexico Conference recommended three sets of actions in support of small-scale mining.

157. The first was addressed to national governments urging them to establish funding mechanisms and tax incentives to assist exploration and development activities. It also emphasized the need for direct technical assistance in obtaining information, choice of mining and processing methods, analytical services, procurement of equipment, marketing, etc. Governments were also encouraged to provide necessary infrastructure such as access roads, water and power supplies and even medical services and school. There must also be provision of training facilities, including emphasis on environmental aspects and the promotion of safe working conditions.

158. The second set of actions was addressed to sources of bilateral assistance especially within the framework of technical co-operation between developing countries. Support could be required to strengthen government services relating to all aspects of small-scale material resources management, as implied in the first set of recommendations. Advice and assistance would also be needed in the establishment of national exploration funds and lending institutions, in the setting up of small mining enterprises and co-operatives and in the organization of training programmes. These funding agencies were also urged to encourage the widespread exchange of information on methods and techniques for small-scale mining through workshops and training schemes. A plea was also made for support for small-scale mining through an expansion of the terms of reference of the United Nations Revolving Fund for Natural Resources Exploration and through the granting of loans from the World Bank.

159. In the third set of recommendations, the Conference proposed the continuation of world conferences on a biennial basis and the establishment of an international research and development institute on small-scale mining.

160. Of additional importance for our region is the establishment of a regional small mining network whose organizing committee is based in Lusaka, Zambia, with national contact groups in a number of African countries.

161. The need to promote small-scale mining has been duly emphasized and several courses of action suggested. However, much has not been done so far in this aspect and it is therefore desired that governments take serious action based on the suggestions put forward in order to promote small-scale mining in their respective countries for the betterment of the socio-economic situation of the individual countries.

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